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The Right Data is Required for Good Decision Making

The evolution and proliferation of industrial automation and IIoT devices has created a wealth of data sources. Effectively harnessing this data empowers end-users to make data-driven decisions and add value to any operation.

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Today's factories are smarter than ever and can provide abundant data regarding operational status, equipment condition and energy usage. This incredible availability of data is potentially a huge benefit, but perhaps an even larger challenge.

Part of the reason for this data explosion is the development of industrial automation platforms far beyond their mission of real-time control. These platforms now routinely provide in-depth visualization for operators and readily integrate into Ethernet and fieldbus networks via a wide variety of "smart" field instrumentation and other devices. These smart devices not only offer normal running parameters, but typically report secondary data, status and deep diagnostics.

In fact, new equipment is more likely to be smart than not. Even common "packaged" systems such as industrial air compressors or chillers provide advanced feedback and interface options. Power distribution switchgear performs more than normal protective functions because monitoring of current, voltage, and many other parameters is usually included.

Many solutions are available to integrate older equipment and systems and obtain data from them. An entire class of field devices now provides new ways to sense equipment and environmental conditions, and transmit this data via wired and wireless networks.

But how can an organization effectively consolidate all these systems into a homogeneous and useful platform for storing, viewing and analysis? Even though the data is out there, it is available in many different formats and protocols. And not all data is created equal in terms of volume and importance, so users need a convenient way to select and handle source data.

This single integration question raises many more concerns addressing pain points end user experiences. What methods will allow remote data to be obtained in a timely manner? Can traceability of the data be maintained to ensure quality and a proper foundation for decision making? Is it possible to verify the security and integrity of the data as it is received, and as the resulting information is supplied to those who need it? And most importantly, how can the raw data be processed into actionable information? Answering these questions with the right solutions empowers the end user to make the best possible decisions and develop a data-driven strategy.
Hardware and software architectures are available to assist with integrating systems and turning data from these systems into actionable information. These SRPs are the key to a successful and cost-effective implementation. This white paper looks at helping end users answers these question with the right solutions.

Industrial Automation Data Evolves
Measures of industrial progress have advanced from Industry 1.0 to 4.0:

- Industry 1.0 leveraged water and steam power to help mechanize manufacturing, enabling the first industrial revolution

- Industry 2.0 employed electric power to enable mass production

- Industry 3.0 was categorized by the use of digital computing systems to automate factories and process plants

- Industry 4.0, a term popularized in Germany around 2011, still includes improving operations and efficiency through computing power, but introduces the idea of extreme interconnectivity

To fully implement and realize the benefits of Industry 4.0, not only must machines "talk" with each other, but all the underlying sensors and devices must be transparently available, and the resulting

information must be usefully conveyed to the right people at the right time. Every element must be easily integrated into the whole to make this happen.

Industry 4.0 has become possible due to the proliferation of “smart” devices. Smart devices are now routinely categorized as Internet of Things (IoT) devices, and if they are hardened for industrial applications they may also be referred to as industrial IoT (IIoT) devices. Typical IoT device features feature powerful wireless or wired connectivity, standardized communication protocols, and the ability to deliver a wide range of data. Additionally, IoT devices are often reasonably priced and economical to deploy.

Prior to the rising availability of IoT devices, traditional industrial sensing technologies were more expensive and challenging to integrate, but the opposite is now true. Older devices often provided only a single channel of data and were hardwired into input/output (I/O) modules, driving up the installation cost. Even if they were networkable it was via specialized digital communication protocols.

Today’s computers and industrial controllers are fully compatible with commercial Ethernet, as are most IoT devices. Therefore, with the wide variety of IoT devices easily integrated into networks, the amount of raw data available to end users has increased by orders of magnitude.

Collectively, this large amount of data, which must be “mined” to provide useful insights, is often referred to as “big data”. *The Economist* finds historical parallels regarding the importance of data: “Data are to this century what oil was to the last one: a driver of growth and change. Flows of data have created new infrastructure, new businesses, new monopolies, new politics and—crucially—new economics.” (Reference 1).

On the surface, more data by itself might seem like a good thing. In reality, escalating quantities of data filling up databases and spreadsheets can overwhelm end users. But if the data is processed properly, end users can take full advantage of it.

Benefits of Data Done Right

To paraphrase a well-known adage, “a person with one watch knows what time it is, but a person with two watches is never quite sure”. Perhaps in a stricter sense, the first part of that saying could better read “a person with one watch *thinks* they know what time it is”. Either way, this proverb is a simple way of stating “too much data can be worse than the right amount of veritable data”.

Given the fact that almost every device capable of being interconnected with computers or automation systems today is “smart”, an ocean of raw data is available. The challenge becomes distilling this volume of data into a drinkable stream. Thousands of data points must be processed into a useful format, often using visualization software. This is what transforms the raw data into actionable information.

The resulting benefit for end users is the ability to use this information in support of effective data-driven decisions about how to improve their businesses and operations. Table 1 identifies some of the many benefits of a process data visualization solution and these are explored in the following paragraphs.

Table 1, Benefits of a Process Data Visualization Solution

- Real-time monitoring for fast response to problems
- Dashboards summarize information for immediate recognition
- Mobility options and remote management provide flexibility
- Key performance indicators (KPIs) helps organizations focus
- Overall equipment effectiveness (OEE) analysis empowers operations
- Ready visibility of energy consumption
- Verifiable basis for optimizing operations
- Effective access to available diagnostics

Data visualization in years past often meant operators needed to manually log system readings on clipboards, and office personnel would compile this information into reports by hand later in the week or month. Even assuming no errors were made, this was a labor-intensive process which introduced a significant lag time. In many cases, once a problem was recognized from a report, it had already caused significant problems.

Timeliness is a prime benefit of a properly configured process data visualization solution. Data is continually logged and processed, so the resulting visualization format is instantly available. Whether the information is presented as trends, graphical charts, or in a tabular format—users are looking at near real-time results. This means problems can be recognized and resolved quickly.

One popular visualization format is called the “dashboard” display. Just as with the dashboard in a car, this type of display is designed to provide at-a-glance information, with emphasis on problems or out-of-range metrics. The dashboard is a tool for users to quickly understand how the system is running, and a jumping off point to perform more detailed analysis. Since it is typically a web-based presentation, the dashboard lends itself to easy deployment.

More detailed displays are often categorized as human machine interface (HMI) graphics, and can be used by operators to run the processes. Another popular feature is the ability to include a certain amount of video surveillance to help end users better visualize operations.

Process data visualization dashboards are a natural fit for the wide range of mobility devices and wireless connection options available today. Instead of limiting dashboards to fixed desktop computers, it is possible to make web views available to those who need them throughout an organization. Even more flexibility is gained by deploying and remotely managing these views on mobile devices such as laptops, smartphones and tablets.

Dashboard data typically consists of KPIs, which are any values derived from actual measurements, and indicate how well the business is operating. These KPIs vary for different types of business, and for different areas within a business.

When companies look at process data to improve their operations, it is fairly straightforward to determine how much raw material went in, and how many widgets came out. However, it requires a deeper level of investigation to understand why the number of widgets produced varies from day to day.

One category of KPI called OEE is structured to provide just this kind of information. The underlying measurements involve how much of the operational equipment is available to run, how much it is used when available, how fast it runs when used, and the quality of the resulting production.

Another KPI often found to be a “low hanging fruit” for streamlining operations and reducing cost is energy consumption. Monitoring and displaying energy usage (any resource such as water, gas, electricity, steam) may lead to the discovery of waste. Or, once a normal operating profile is established, high resource usage can indicate faulty equipment or abnormal operation.

Data visualization systems are very adept at obtaining, processing, and presenting exactly this type of information. They are also crucial for taking the next step, which is inspecting the data to discover trends and cause-and-effect relationships. *Fast Company* notes that “Using advanced analytics to mine

the ever-increasing cloud of digital dust can uncover hidden patterns and generate deep insights. Such is the promise of applied data science." (Reference 2)

Process data visualization systems tirelessly gather data and accurately compile it into informational displays so businesses can optimize their production. In addition, the underlying data can include diagnostics which help technicians and maintenance personnel keep equipment running smoothly. When an organization is ready to realize these benefits, they need to select the right system.

Building the Data-Driven Architecture

Any data-driven architecture will include hardware, software, and networking components. The most flexible solutions will incorporate commercial off the shelf (COTS) technologies for the best performance and cost effectiveness, and will be tailored to integrate with existing systems, while offering the ability to grow in the future. These "open" platforms afford end users the greatest flexibility moving forward.

A complete offering will accomplish the goals listed in Table 2. End users should demand these features when selecting a robust process data visualization architecture. Many of these objectives boil down to one basic concept: a data-driven architecture must easily communicate with a wide variety of components and systems.

Table 2, Requirements for a Robust Process Data Visualization Architecture

- Connectivity with all types of networks.
- Interoperability with all types of IoT sensors and components (edge intelligence)
- Protocol conversion capabilities
- Detailed shop floor visualization
- Dashboard info available everywhere
- Powerful web access
- Compatibility with open cloud storage
- Seamless MES/ERP and other upper layer computing system integration with openAPI

The quest for a data-driven architecture typically begins by ensuring the components can electronically connect to all types of networks which might be encountered, whether wired and wireless. Fortunately, this is simplified somewhat today since Ethernet has become the de facto standard. However, in the industrial space and elsewhere it is also important that RS-232 and RS-485 serial connectivity be offered, as well as various fieldbus options.

Data visualization solutions may connect to IoT sensors directly, or to I/O modules, or to other more intelligent components out near the "edge" of the production system such as variable speed drives or programmable logic controllers (PLCs). Therefore, the solution must easily interoperate with all these devices, which usually means it must be capable of converting among hundreds of digital communication protocols.

Once data connectivity is established, the solution must include provisions for displaying content to end users. This includes shop floor personnel and operators who would typically use an HMI-type presentation, as well as management personnel more likely to use a dashboard view. A comprehensive data visualization solution will include options to deploy all these types of displays wherever they are needed, either locally in a facility or remotely over the web. Hardware viewing options must include desktop PCs, laptops, smartphones and tablets.

A powerful way to achieve web access is to ensure the data solution is compatible with open cloud storage. In this way, end users use inexpensive cloud storage solutions to securely store their data and make it available globally.

Many end users already have other powerful software systems in place performing manufacturing execution system (MES) and enterprise resource planning (ERP) functions. The most capable data-driven architectures will offer integration to these systems using an openAPI interface.

Choosing the Right Solution for Data-Driven Decision Making
To achieve complete component connectivity and bridge data easily to a process visualization system, users could assemble a variety of pieces and parts. While this approach would seem to offer the ultimate flexibility, it also introduces a significant risk of incompatibility, and would require a degree of up front engineering.

Another more practical method is to begin with a proven solution which can be expanded and adapted as required. As an industry leader in providing automation hardware, software, and networking products—Advantech is ideally positioned to offer these types of solutions—and offers several "solution-ready platforms" (SRPs) to enable data-driven decision making.

The Equipment Connectivity Solution (SRP-FEC220) is intended to be installed closest to the field, and includes a system computing unit able to interface with local controllers and I/O. The package also includes the company's WebAccess/HMI software.

Moving up in the hierarchy, the Process Visualization Solution (SRP-FPV220) includes an industrial computer and WebAccess/SCADA software, and is optimized for providing shop floor visualization, "dashboard everywhere" capabilities, and connectivity to higher level MES systems.

Each of these solutions is targeted at achieving the goals for a robust data-driven architecture. They are designed so end-users can select the elements they need, and are compatible with each other to

support growing user needs. Not only does this reduce the risk of implementing the solution, but it minimizes the labor and time to get the data visualization system up and running. Here are some examples of how to implement these data-driven infrastructures.

Making Manufacturing Smarter

Many manufacturing facilities include production lines consisting of a series of packaged equipment performing different functions. For instance, the figure below depicts an assembly line which may include various packaged systems such as screen printing equipment, chip placement stations, inspection stations and a solder reflow oven.

Packaged equipment is often procured from various vendors, each chosen because they produce best-of-breed equipment for a particular operation. Although each subsystem is very capable, in the event of a production slowdown it may not be obvious where the inefficiencies lie.

Because each piece of packaged equipment has various purposes and underlying technologies, this is an ideal situation for applying Advantech's Process Visualization SRP, overlaying it on the production line.

Wi-Fi remote I/O modules can be installed at strategic locations to monitor available equipment status signals. Using existing Wi-Fi infrastructure economically allows these modules to report back to an industrial computer. This is also an opportunity to add in sensors and instrumentation which did not originally come with the equipment. Another capability is to add tower lights on the production floor with red, yellow and green indications to alert operators to potential bottlenecks.

An industrial PC is provided with Advantech's SCADA software, which includes a sample project as a starting point template for easier development. End users can configure the SCADA software to create an overall dashboard meaningful for their operation. The SRP platform contains all the building blocks needed. Dashboards can be deployed for supervisors, and can even be provided on large screen displays visible to operators so they can get performance feedback.

Newfound Visibility

An air conditioner evaporator coil assembly facility had production lines with fin press machines, expander machines and dry ovens. Similar to the previous example, the end user needed to obtain comprehensive production information. However, they wanted to dive even deeper into the available information. Implementing Advantech's Equipment Connectivity and Process Visualization SRPs was the answer.

Since the existing production line had several brands of PLCs, the Equipment Connectivity SRP was crucial to establishing communications with each of them. This allowed the customer to collect real-time information including detailed values such as machine speed, critical alarms, temperature, throughput count, and run/stop status and times.

In conjunction with this data gateway, the Process Visualization SRP provided a seamless way to display the newfound data. In addition to a dashboard, other extended capabilities included production reports, and emailed or texted alerts for critical problems. The end user now has enough detailed information to truly optimize production and minimize equipment downtime.

Conclusion and Outlook

Industrial automation technology has evolved far beyond basic control, and now encompasses advanced capabilities which end users can tap to optimize their operations. Instruments and sensors categorized as IIoT components offer up extended data via networking connections. In fact, most digital devices and packaged equipment include enough intelligence to be considered "smart devices". Networking and communication protocol standards have improved the interconnectivity situation.

The importance of big data can't be understated. As *Forbes.com* observes, "Data has been the crux of corporate productivity, transformation and effectiveness challenges for decades. Yet it is largely shuffled aside because solving the root data problem is hard and requires lots of human effort as this is not quick technology fix." (Reference 3). As this white paper has demonstrated, tools are now available to facilitate access to industrial big data, while reducing the required human effort to a manageable level.

However, this proliferation of available data must be utilized in an effective manner to keep the end user from drowning in numbers. An aggressive grab for all possible data without a plan for organizing will fail, so comprehensive data visualization architecture is crucial.

Properly designed data systems will provide dashboard-type overall visualization, offering up the most important KPI and OEE information, which allows users to understand how their manufacturing operations are running. Visualization must be securely available on the plant floor, in the front office, and on mobile devices. Furthermore, end-users need the tools to dive into the details required to optimize their systems, and to make the best possible data-driven decisions.

SRPs are available to help end users reach their data visualization goals, while minimizing the risk and cost associated with development. Advantech offers several SRPs focused on connecting to sensors and components to providing process visualization, and extending to advanced cloud connectivity and database storage. These packages are ready to integrate with any automation or manufacturing operation.

References:

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